



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

ADDITIONAL OBSERVATIONS ON THE GEOLOGY OF KANSAS.

By LYMAN C. WOOSTER, Ph. D., Emporia.

ILLUSTRATION OF CLASSIFICATION FORM.

<i>Formations.</i>	<i>Times.</i>	<i>Rocks.</i>
Paleozoic.....	Eon.	Series.
Carbonic.....	Era.	System.
Coal Measures or Kansan.....	Period.	Group.
Upper Coal Measures or Upper Kansan.....	Epoch.	Stage.
Lower Coal Measures or Lower Kansan.....	Epoch.	Stage.
Emporia Beds.....	Hemera.	Beds or substage.

Carboniferous Rock System of the Carbonic Era.

Thickness, 5555 feet. Time, about 2,500,000 years.

The rock groups and the corresponding time periods:

- I. Mississippian.
- II. Coal Measures, or Kansan.
- III. Permian.

I. ROCKS OF THE MISSISSIPPIAN PERIOD.

But one rock stage of the Mississippian period is represented in Kansas, that of the Keokuk epoch.

1.—*Strata of the Keokuk Epoch.*

The rock beds found in southeastern Kansas. Thickness, about 400 feet.

(1) *Galena (Boone) Beds*, thickness about 400 feet. These consist of layers of bluish limestone. In the upper portion of these beds the limestone has been extensively eaten out, probably by water containing carbon dioxide, and great quantities of chert, lead sulfide and zinc sulfide have been deposited in the cavities. The ores of lead and zinc are extensively mined at Galena, and in the vicinity of Joplin, Mo. The annual output is worth about \$10,000,000 for both metals. The ores are smelted at Cherryvale, Iola, Chanute, Neodesha, and Pittsburg. At about the close of this epoch, the Galena beds were raised above the level of the sea and deeply eroded by sub-aerial agencies. The amount of this erosion is unknown. A deep well at Emporia reached the Galena beds of the Mississippian limestone at a depth of 1920 feet. The level of the surface at the mouth of the Emporia well is 1130 feet above the level of the sea; the level at Galena above the same datum plane is 870 feet. The distance from Galena to Emporia in a straight line is 118 miles; therefore the dip of the Galena beds

in the direction of Emporia is about sixteen feet to the mile, assuming that the upper layers of these beds exposed near Columbus would have an elevation of 1100 feet at Galena were they still exposed at that place.

II. ROCKS OF THE COAL MEASURE OR KANSAN PERIOD OF THE CARBONIC ERA.

Thickness, 2780 feet.

1.—*Strata of the Lower Coal Measure or Lower Kansan Epoch.*

The rock beds found in eastern Kansas. Thickness, 1440 feet. (The layers are described, beginning with the lowest.)

(1) *Cherokee Beds*, thickness, 450 feet. This formation consists largely of shales, a few thin layers of limestone, several beds of sandstone of various thicknesses, becoming increasingly prominent to the southward, and of seven or more beds of coal. The shales are valuable for brick-making, and the sandstones serve as rich reservoirs of petroleum and natural gas under a belt extending from Paola to Coffeyville and south into Indian Territory. The Weir City coal-bed, situated about 200 feet above the base of the Cherokee beds, yields the coal mined near Pittsburg and probably that mined at Atchison, Leavenworth, and in eastern Indian Territory.

Nearly eighty-five per cent. of the coal, ninety-nine per cent. of the natural gas and ninety-nine per cent. of the petroleum mined in Kansas are obtained from the Cherokee beds. It is estimated that, during 1904, 5,000,000 tons of coal, 7,000,000 barrels of petroleum and an unknown number of billion cubic feet of gas were obtained from these beds; and that from these and the other beds of the Lower Coal Measures were obtained 150,000,000 brick of various kinds and 2,700,000 sacks of cement—all, coal, oil, gas, brick, and cement, worth more than \$16,000,000.

The Cherokee beds dip heavily to the southward in southeastern Kansas, increasing to a thickness of more than 9000 feet in eastern Indian Territory. Probably these beds in Indian Territory are the source of the petroleum and natural gas of eastern Kansas. If so, middle Kansas does not overlie this sheet of gas and oil, and, therefore, cannot obtain them from the sandstones of the Cherokee beds.

The Cherokee beds outcrop in Cherokee, Crawford and Bourbon counties, but are penetrated by wells and shafts throughout eastern Kansas, as they dip at a small angle to the westward. Fossils are not abundant in these beds.

(2) *Labette Beds*, 110 feet. These consist of the Fort Scott (Oswego) limestones, twenty-five feet; Labette shales, sixty feet;

and the Pawnee limestone, twenty-five feet. The limestones abound in low anticlines and synclines, and may be easily traced along a line extending from Fort Scott southwestward. Excellent outcrops may be found near Girard, Oswego, and Parsons. The lowest limestone is burned for cement near Fort Scott. Fossils are abundant near the decomposing limestones. The shales thicken to the southward.

(3) *Pleasanton Beds*, 275 feet. These beds include the Bandera (Lower Pleasanton) shales, 100 feet; Parsons (Altamont) limestone, 25 feet, and the Dudley (Upper Pleasanton) shales, 150 feet. The Parsons limestone thins northward and disappears near Pleasanton. Coal is mined at Pleasanton, and some thin layers of sandstone are quarried for flagging on the Marmaton river near Fort Scott. The shales are thicker southward.

(4) *Erie (Bronson) Beds*, 275 feet. These include the Hertha (Bethany Falls) limestone, 15 feet; Ladore (Mound Valley) shale, 100 feet; Mound Valley limestone, 10 feet; Cherryvale (Galesburg) shales, 120 feet, and Independence (Dennis) limestone, 30 feet. The limestones of the Erie beds are best developed to the northeastward, and become thinner bedded and more argillaceous to the southwestward. They contain many fossils. The shales thicken southward, and contain much arenaceous material. They supply excellent clay for vitrified brick, especially at Cherryvale. The Erie beds are a dominant feature of the topography of the country from eastern Miami county to eastern Montgomery county. The shales thin to the northward.

Remarks: In the eastern part of Allen and the western part of Bourbon counties the Erie (Bronson) beds lose in part the shale strata, and the limestones thicken so as locally to form an almost continuous bed of limestone sixty to eighty feet in thickness. This is one of the heaviest of the limestones penetrated in drilling for oil. The Independence limestone of these beds carries a large amount of flint in its lower portion; the upper portion is an oolite which exhibits cross-bedding and false bedding, and attains a thickness in some places of fifteen feet.

(5) *Iola Beds*, thickness 330 feet. These include Chanute (Thayer) shales, 150 feet; Iola (Earlton) limestone, 30 feet; Concreto (Lane) shale, 75 feet; Allen (Stanton, Garnett, Carlyle) limestone, 30 feet; Vilas shale, 45 feet. The shales of the Iola beds are better developed in thickness southward, and the Chanute shales contain much sandstone in the central and southern counties

and in Indian Territory. The sandstone is not well cemented and is everywhere ripple-marked, showing shallow-water deposition. The limestones become thinner-bedded to the southward and are inconspicuous. Thin beds of coal in the shales are mined locally. The Iola beds outcrop along a belt extending southwestward from Kansas City, Mo., by Paola, Iola, and Fredonia, to western Montgomery county. Portland cement is manufactured from shale and limestone at Iola. A warping of the crust of the earth by which the deep seas were shifted from south of Kansas to north of Kansas makes the close of this hemera a proper time for dividing the Coal Measure or Kansan period into Lower and Upper Coal Measures, or Lower and Upper Kansan epochs.

2.—*Strata of the Upper Coal Measure or Upper Kansan Epoch.*

The rock beds found in eastern Kansas. Thickness, 1340 feet. (The layers are described, beginning with the lowest.)

(6) *Lawrence Beds*, 310 feet. These include Piqua limestone, 50 feet; Le Roy shales (Lawrence shales, north; Chautauqua sandstone, south), 220 feet; Oread limestone, 40 feet. The shales thicken northward, and are replaced by sandstones southward. A few thin beds of coal are mined locally in the shales, and some light flows of natural gas have been obtained from them by wells at Eureka. The important towns located on or near the outcrop of these beds are Troy, Atchison, Leavenworth, Lawrence, Burlington, Toronto, Yates Center, Fall River, Elk Falls, and Sedan.

(7) *Lecompton Beds*, 280 feet. Kanwaka shales (Elgin sandstone, south), 100 feet; Lecompton limestone, 20 feet; Tecumseh shales (Cave Springs sandstone, south), 75 feet; Deer Creek (Strawn) limestone, 25 feet, and Calhoun shales, 60 feet. The shales are thicker north, and quite arenaceous in the southern part of the state. The limestones do not form conspicuous ledges, except on the Kaw river and in the southern counties. Fossils are very abundant, especially in the vicinity of the limestones. The important towns on or near the outcropping of this belt of beds are Lecompton, Lyndon, Hilltop and Virgil in Greenwood county, Elk Falls in Elk, and Elgin in Chautauqua county.

(8) *Eureka Beds*, 230 feet. Hartford (Topeka) limestone, 25 feet; Severy (Osage) shales, 70 feet; Howard limestone, 7 feet; Burlingame shales, 120 feet; and Barclay (Burlingame or Eureka) limestone, 8 feet. All these limestones, especially the last, form prominent escarpments across the state. The eighteen-inch bed of coal mined at Osage City, Burlingame and Scranton lies at the top of the Severy shales, just under the Howard limestone. Several

thin beds of coal are found in the Burlingame shales, and yield some coal by stripping. Hiawatha, Holton, Topeka, Osage City, Eureka, Howard and Cedarvale are situated along this belt of beds. The Burlingame shales eight miles east of Emporia contain so much arenaceous material that in certain portions they are better designated as sandstones. These arenaceous shales are intersected vertically by numerous fissures, many of which show faulting. About thirty feet below the Barclay limestone is a two-foot stratum of concretionary limestone covering a six-inch stratum of coal, and fifty-five feet below the Barclay limestone is a stratum of brecciated and conglomeritic limestone, locally thirty-five feet thick. The same or another stratum of breccia and conglomerate is found above the concretionary limestone mentioned above, and another thin stratum above the Emporia limestones, described below, is widely distributed in Lyon county.

(9) *Emporia Beds*, 216 feet. These comprise the Humphrey shales, including Columbia Ford limestone, 36 feet; Emporia blue limestone, 9 feet; Olpe shales, 60 feet; Emporia buff limestones, 34 feet, and Emporia reservoir shales, 77 feet. The Humphrey shales yield much salt water, to the detriment of wells. The Emporia blue limestone holds its special characteristics throughout Lyon county and probably also in the counties north and south, and is much used in the construction of foundations to houses. The Emporia buff limestones are five in number, vary considerably in physical appearance, hold many fossils in the limestone layers and in the intervening shales, and are locally used somewhat for building stones. Beneath the Emporia buff limestones the Olpe shales are in part quite arenaceous. These shales contain a thin bed of coal in the middle part. The Emporia reservoir shales are quite uniformly arenaceous and carry at the top a six-inch bed of coal.

(10) *Americus Beds*, 155 feet. These comprise the Admire shales and limestones, 120 feet; Americus limestone and shales, 35 feet. The Admire shales include some five strata of limestone and sandstone, none of which is of especial importance commercially or topographically. About ninety feet above the base the shales yield small quantities of natural gas in western Lyon county, and larger quantities at Strong City and Elmdale, in Chase county. The Americus limestone is a valuable building stone. It is dark buff in color and averages twenty inches in thickness. Six or eight feet above the Americus limestone is a six-inch layer of limestone

much used for sidewalks. The shale between these limestones is very rich in fossils.

(11) *Elmdale Beds*, 150 feet. One-third of the thickness of these beds is limestone, and the remainder is shaly limestone and shale. Of these limestones, three deserve special mention: The Friable Fusulina, twenty-four feet above the base of the beds, contains myriads of rhizopods. The Neva limestone, forty-six feet below the top, is twelve feet in thickness. The upper half was named "cotton rock" by Swallow, an early Kansas geologist, and the lower half was named "dry bone," from its peculiar appearance when weathered. The Cottonwood limestone, twelve feet from the top of the Elmdale beds, is one of the most highly valued building stones of middle Kansas. It is a white limestone, and lies in a stratum six and one-half feet in thickness. The twelve-foot shale bed above this limestone is literally full of fossils and becomes excellent soil on decomposition.

The Elmdale beds lie at the summit of the Coal Measures of Kansas. No unconformity exists between these beds and those above, but Permian fossils are increasingly abundant.

III. ROCKS OF THE PERMIAN PERIOD OF THE CARBONIC ERA.

Thickness, 2375 feet.

1.—*Strata of the Lower Permian Epoch.*

The rock beds found in central Kansas. Thickness, 565 feet. (The layers are described, beginning with the lowest.)

(1) *Strong City Beds*, 180 feet. These include Crusher Hill alternating shales and limestones, 140 feet. The limestones offer little resistance to atmospheric influences, and, therefore, have little influence on topography. The stratum next above is the Strong flints (Wreford limestone), 40 feet. This formation is chiefly responsible for the Flint Hills of central Kansas, because of its power to resist erosive agencies. The layers of limestone have been replaced wholly or in part by silicious material, and are much used, when crushed, for railroad ballast. The Flint Hills, or, as they were named by the earlier geologists of Kansas, the Permian mountains, extend across the state from Nebraska to Oklahoma, but are best developed in Chase, Greenwood, Butler, Elk, Cowley and Chautauqua counties.

(2) *Florence Beds*, about 159 feet. These consist of Cedar Point (Matfield) shales and shaly limestones, about 92 feet; Florence flints and shaly, buff limestone, 37 feet; Fort Riley (Florence) limestones, 30 feet. In the midst of the Florence flints are one or two heavy layers of white limestone, quarried at El Dorado for fine

building stone. The shaly, buff limestones above the Florence flints contain an abundant brachiopod fauna near Florence, and the shaly limestone above the heavily bedded Fort Riley limestone contains an abundant lamellibranch fauna near Fort Riley.

(3) *Marion Beds*, about 230 feet. The lower portion of these beds consists of various colored shales and shaly limestones, about sixty feet. The next section of the beds contains the Marion gray limestone, with more or less flint, then some yellowish shales, and Marion concretionary limestone, in all thirty feet. The Marion concretionary limestone contains many brachiopods. This is the highest and latest formation of which this is true, for the higher and later formations of the Marion beds are characterized by a very abundant lamellibranch fauna. The next 140 feet of the Marion beds consists of variously colored shaly limestones, with the Abilene conglomerate at the top. This last consists of pebbles of limestone and quartz cemented together. The great change in the physical geography of central Kansas at the close of the deposition of the Marion beds, shown by the absence of fossils from the succeeding beds and the deposition in them of large quantities of salt and gypsum, makes it seem wise to separate the Lower Permian from the Upper Permian at this horizon.

2.—Rocks of the Upper Permian Epoch.

The rock beds found in southwestern Kansas. Thickness, 1810 feet. (The layers are described, beginning with the lowest.)

(4) *Wellington Beds*, about 400 feet. These consist lowest of buff limestones and marls, then of colored shales and marls alternating with layers of gypsum and thick deposits of rock salt, and lastly of variously colored shales and marls. In central and northern Kansas the Wellington beds are succeeded by the massive dark brown and red sandstones of the Dakota Cretaceous; in southern Kansas the Wellington beds are covered by the sandstones, long known as the "Red Beds," belonging to the Upper Permian. Cragin has characterized the Wellington beds as made up of "a thick body of blue, gray and slate-colored shales." Thus far no fossils have been reported from them. Salt is mined at Kingman, Lyons, and Kanopolis, and is pumped at Anthony, Wellington, Hutchinson, and Sterling.

(5) *Harper Beds*, 650 feet. These are the red and variegated sandstones of the Red Beds so well exposed in Kingman and Harper counties. These beds are continuous with similar beds which outcrop in Oklahoma. The sandstones and shales were de-

posited over a continuously subsiding sea bottom, but always in shallow water, as is shown by the ripple-marks to be found in nearly every layer. No fossils have been found in these beds in Kansas, but, in Oklahoma, Gould reports the discovery of vertebrate, invertebrate and plant remains. The animals belong to Permian types, and the plants resemble Mesozoic rather than Paleozoic types, according to European standards.

(6) *Medicine Lodge Beds*, 500 feet. These consist of the Salt Plain shales, containing salt and gypsum, 150 feet; Cedar Hill sandstones, 150 feet; Flower-pot shales, 170 feet; Medicine Lodge (Cave Creek) gypsum, 29 feet. On the discovery of fossils in Oklahoma in strata geologically more than a hundred feet above the Medicine Lodge gypsum, Gould classed the strata above as Triassic; but a more careful study of these fossils shows that they belong to Permian types, and it is therefore probable that the Texas Trias does not extend north into Kansas. In southwestern Colorado the Permian Red Beds and the Triassic are unconformable.

(7) *Kiger Beds*, 260 feet. These consist of Dog Creek shales, 30 feet; Red Bluff sandstones, 200 feet; Day Creek dolomite, 10 feet; Hackberry shales, 20 feet. The fossils referred to in (6) were found in the Red Bluff sandstones. The Kiger beds close the Paleozoic in Kansas. The whole region covered by Coal Measure deposits was elevated at the close of the Paleozoic. It remained dry land during the Triassic and Jurassic of the Mesozoic, and was deeply eroded; and then was submerged, in the western half of the state, beneath the waters of the ocean and covered by the deposits of the Cretaceous era, and later, as the land slowly emerged from the ocean during the rise of the Rocky Mountains in the next tier of states, west, became covered by the brackish and fresh-water deposits of the Tertiary and Quaternary eras.